



## Site appraisal service

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### Why?

1. Reduce the risks in resource assessment in the process of developing bankable renewable energy projects
2. Support local authorities and potentially, financial institutions with a method for qualifying and screening renewable energy sites earmarked for development

### Appraisals completed so far...

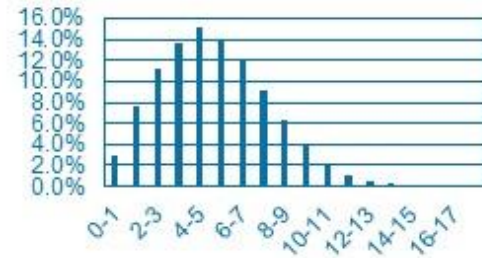
1. Two (2) wind sites in Cape Verde with a combined capacity of 4.8 MW
2. Four (4) wind sites in Comoros Island, with each one of them being explored for a potential 2MW farm

# The service entails...

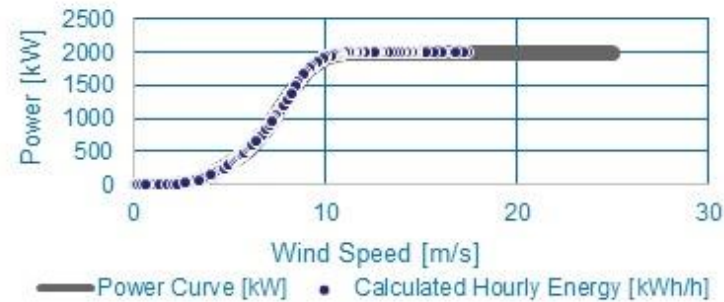
## Data Analysis, Power Simulation & Financial modelling

### 1. Wind data analysis – inter-annual variability, direction and frequency distribution

Spatial resolution	3km
Length [years]	10.0
Mean wind speed [m/s]	5.1
Max wind speed [m/s]	18
Min wind speed [m/s]	0
Inter-annual variability	3.42%
Air density [kg/m <sup>3</sup> ]	1.159



### 2. Power simulation curve



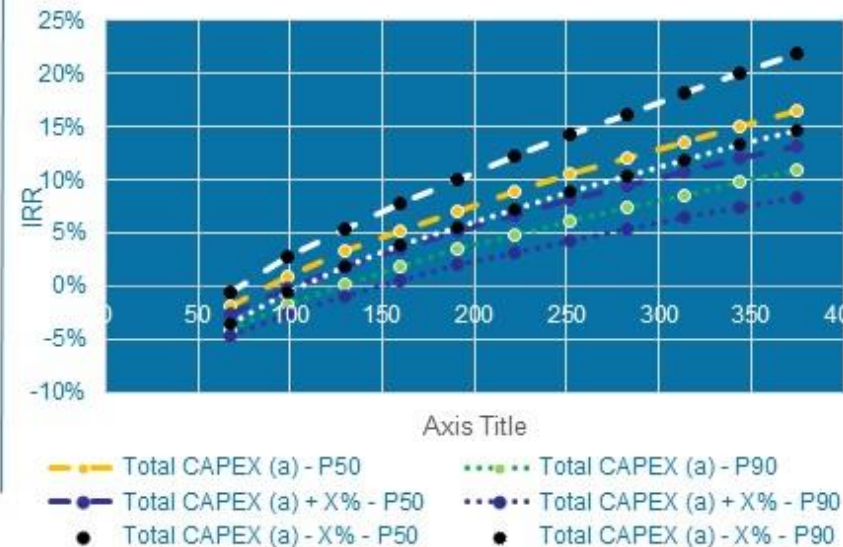
#### Production estimates

P25 (MWh/Year)	4,836
P50 (MWh/Year)	4,161
P90 (MWh/Year)	2,879

### 3. Financial model – cash flow model, NPV, IRR and Sensitivity analysis

**Base scenario:** P50, Tariff \$200.6/MWh

NPV net income before tax	1,714,106
IRR before tax	11.44%
NPV net income after tax	-15
IRR after tax	8.00%
LCoE (per MWh)	165.08



## Possible result interpretations

1. The site is economically feasible – within a given tariff range (in US cents/kWh)
2. The site is marginally feasible – *only under certain conditions i.e. high current tariff and very low financing costs*
3. Marginally feasible – *only when pooled with several other economically feasible sites*
4. Not economically feasible

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The following is the formula for calculating NPV:

$$NPV = \sum_{t=1}^T \frac{C_t}{(1+r)^t} - C_0$$

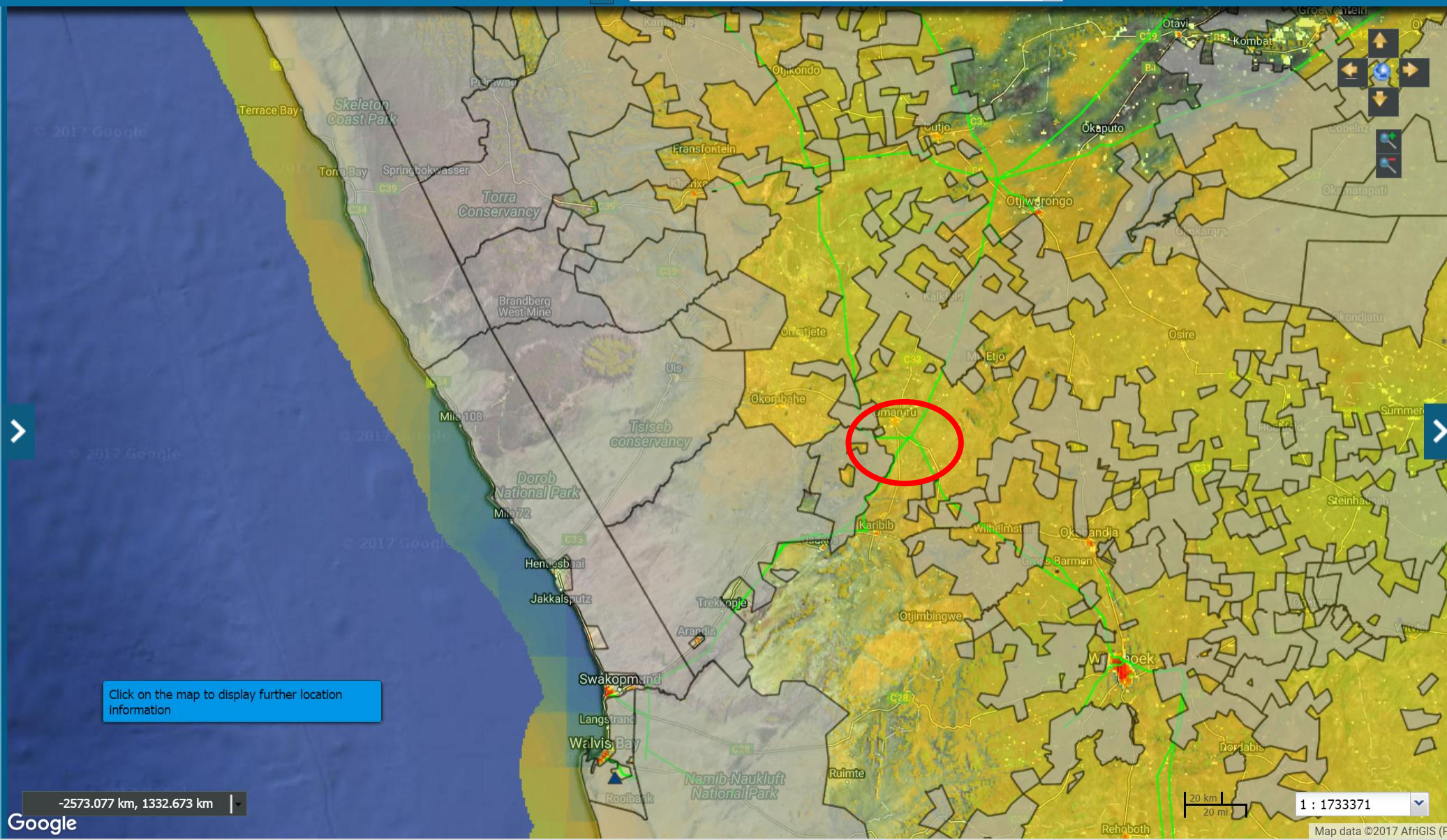
where

$C_t$  = net cash inflow during the period t

$C_0$  = total initial investment costs

r = [discount rate](#), and

t = number of time periods



Tools & Services

Legend Tools My processes

Wind power plants April 2016

Edit Legend Predefined Styles

Wind Farms

World Database on Protected Areas World polygon UNEP 2012

Edit Legend Predefined Styles

Protected area

Global power lines OpenStreetMap 2015 extract

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OSM Power Lines

Average WS 1km at 100m height DTU 2015

Edit Legend Predefined Styles

- 2 m/s
3 m/s
4 m/s
5 m/s
6 m/s
7 m/s
8 m/s
9 m/s
10 m/s
11 m/s
12 m/s

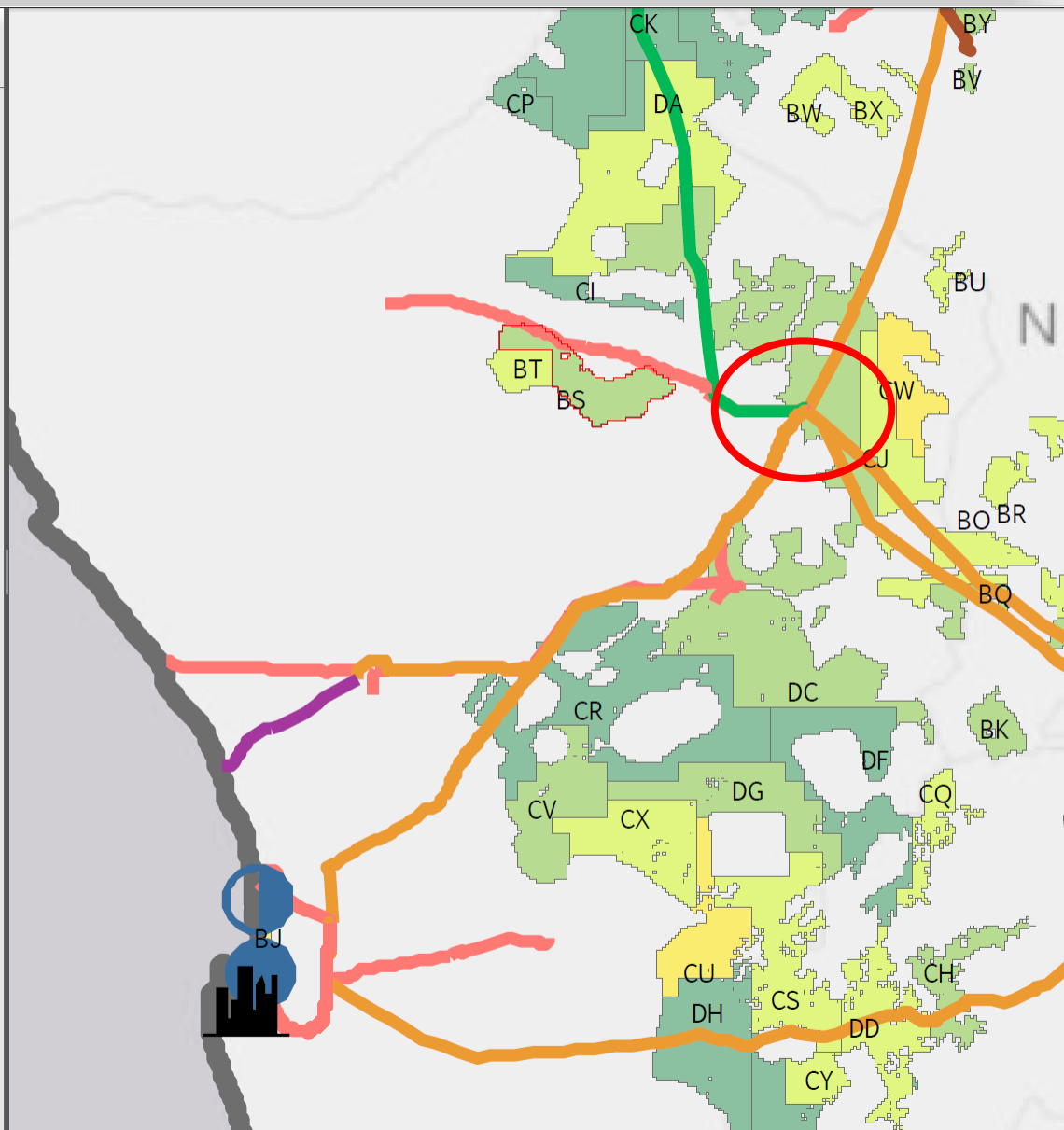
Click on the map to display further location information

-2573.077 km, 1332.673 km

Google

Model Tree

Property	Value
zone_identification	BS
electricity_generation_discounted_chosenTurbine...	2630000
electricity_generation_discounted_classIlturbine_...	2270000
installedCapacity_MW	1080
area_km2	479
LCOE_transmission_chosenTurbine_USDperMWh	3.55
LCOE_substation_chosenTurbine_USDperMWh	3.91
LCOE_road_chosenTurbine_USDperMWh	0.86
LCOE_generation_chosenTurbine_USDperMWh	101.72
LCOE_generation_classIlturbine_USDperMWh	104.87
LCOE_total_transmission_chosenTurbine_USDper...	106.13
LCOE_total_transmission_classIlturbine_USDperM...	109.99
LCOE_total_substation_chosenTurbine_USDperM...	106.49
LCOE_total_substation_classIlturbine_USDperMWh	110.41
mean_slope_percent	2.13
mean_populationDensity_personsPerKm2	1.59
mean_LULC_score	2.29
mean_colocation_score	1
num_projectsWithWaterAccess	0
mean_resourceQuality_Wperm2	230
mean_capacityFactor_chosenTurbine	0.279
mean_capacityFactor_classIlturbine	0.24



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namibia\_interactive\_MapRE...

1 file / 2.67 MB

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Change

Convert

Create PDF

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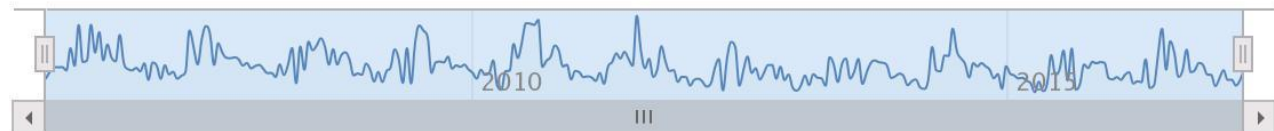
Combine PDF

Send Files

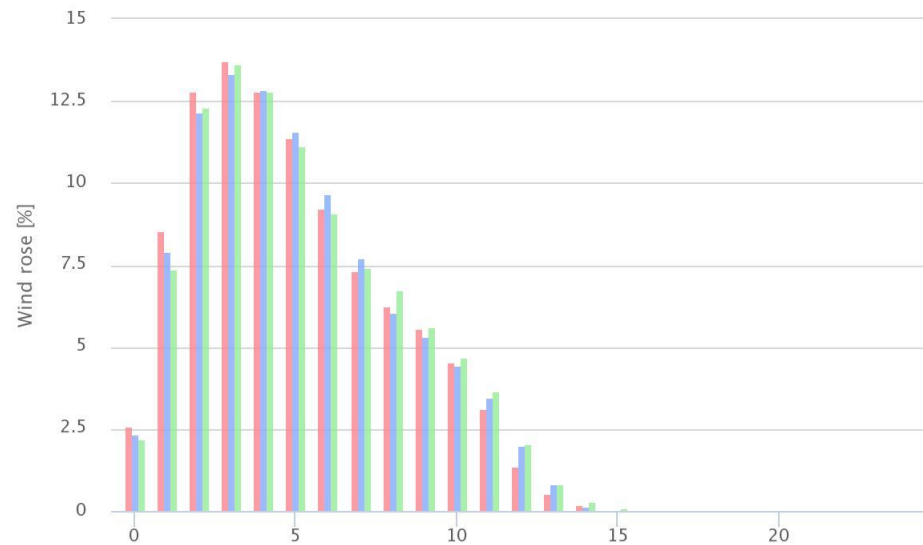
Store Files

# Speed [m/s]

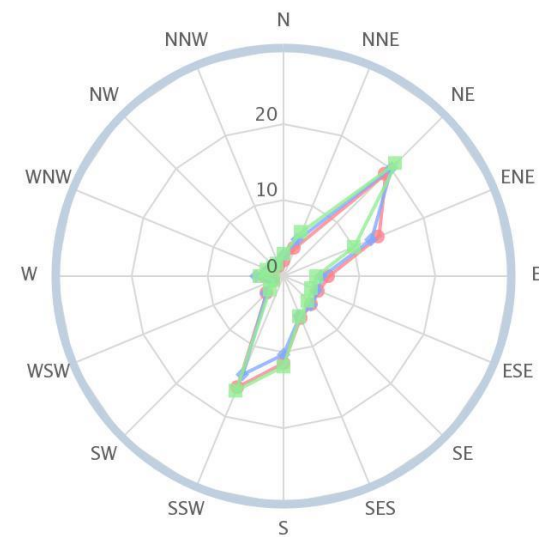
Zoom **1m** 3m 6m YTD 1y All From  To



# Wind Speed Distribution [m/s]



# Wind rose





Select Wind Data #1

Select Wind Data #2

Select Wind Data #3

#1

MERRA 2 at 80m

60  
10.0  
5.6  
17.4  
0  
3.90%  
1.027

#2

ERA at 80m

60  
10.0  
5.6  
17.2  
0  
2.45%  
1.028

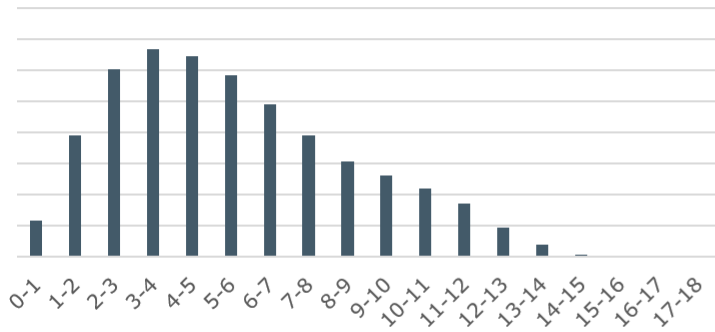
#3

CFSR at 80m

60  
10.0  
5.5  
17  
0  
6.87%  
1.027

5]

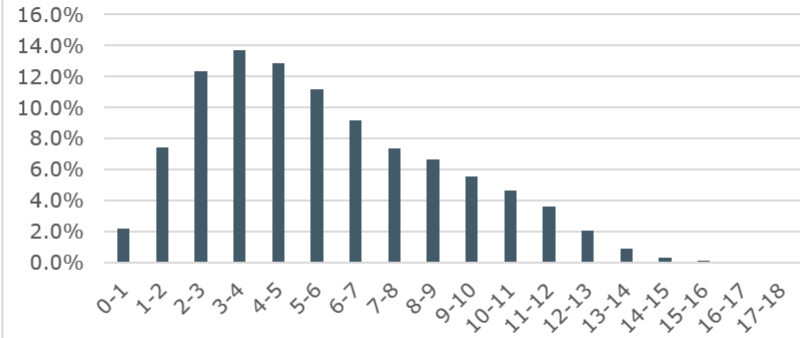
Wind Speed Frequency Distribution



Wind Speed Bin [m/s]

Freq. [%]

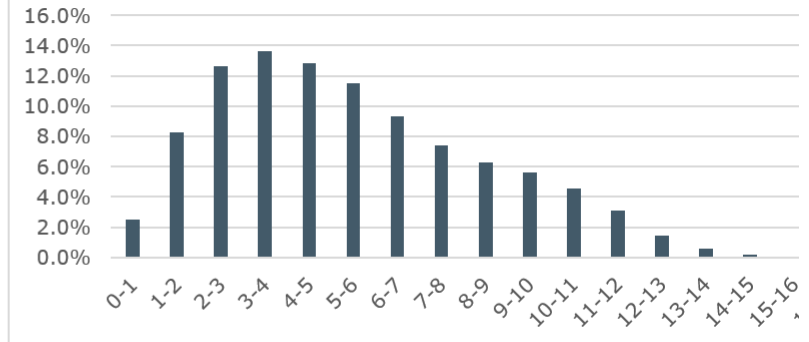
Wind Speed Frequency Distribution



Wind Speed Bin [m/s]

Freq. [%]

Wind Speed Frequency Distribution



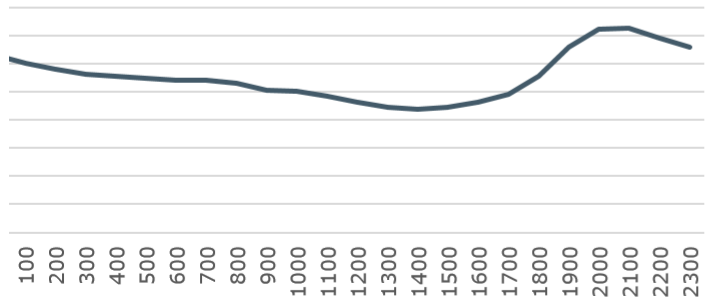
Wind Speed Bin [m/s]

Wind Direction Distribution



f [m/s]

Average Daily Cycle

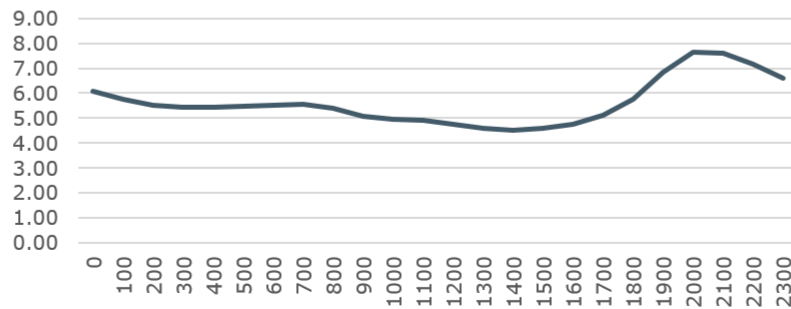


Wind Direction Distribution



Average of [m/s]

Average Daily Cycle



[HHMM] ▾

Wind Direction Distribution

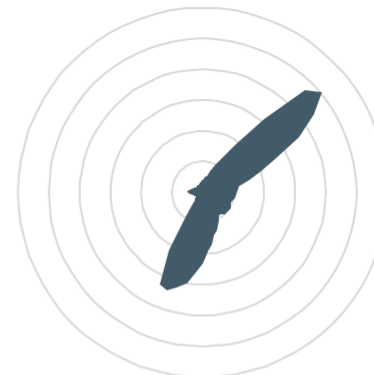
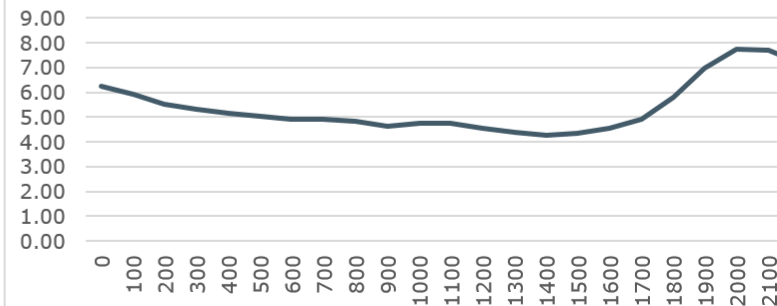


Chart A

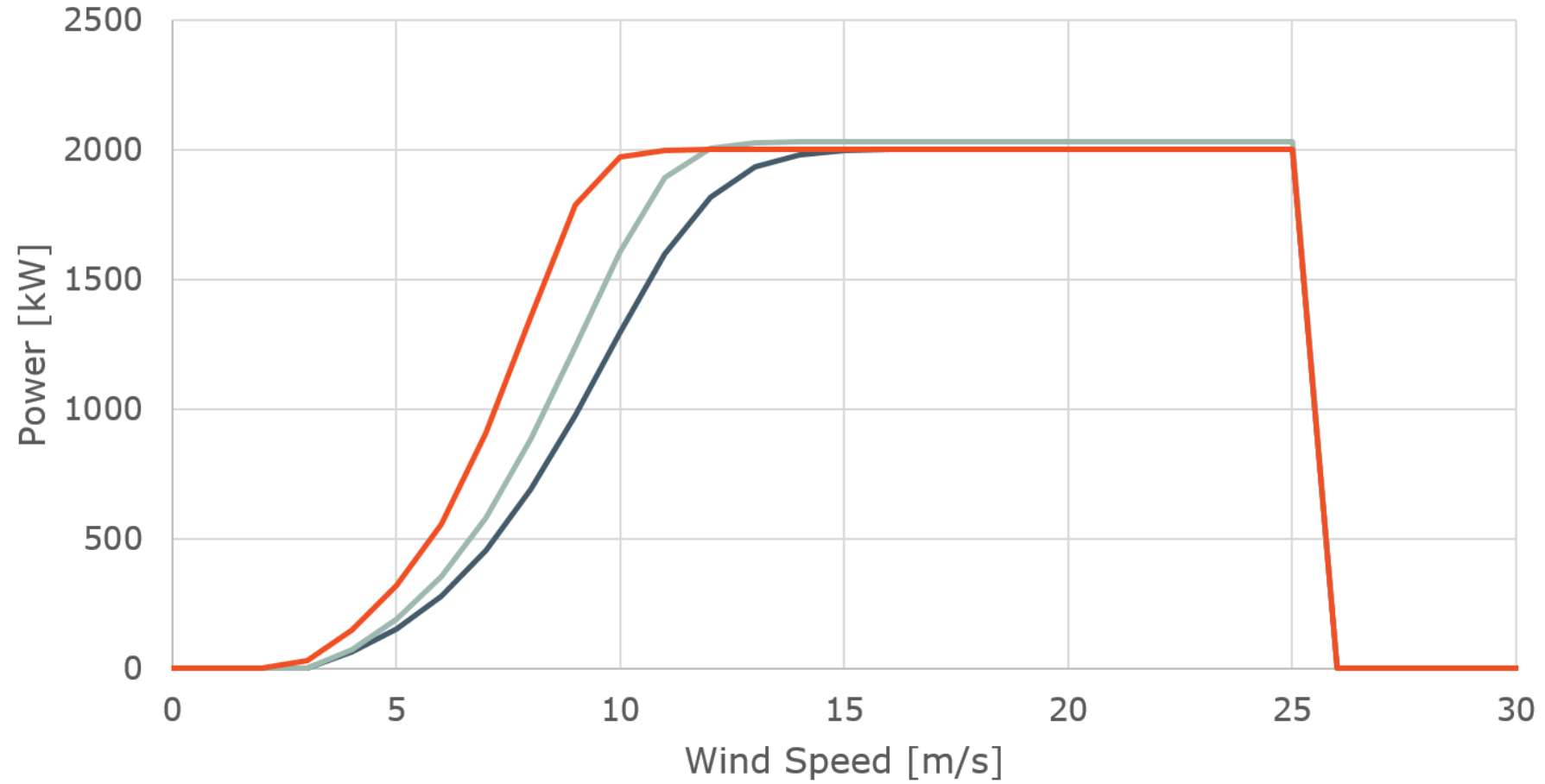
Average of [m/s]

Average Daily Cycle



[HHMM] ▾

# Power Curve Comparison

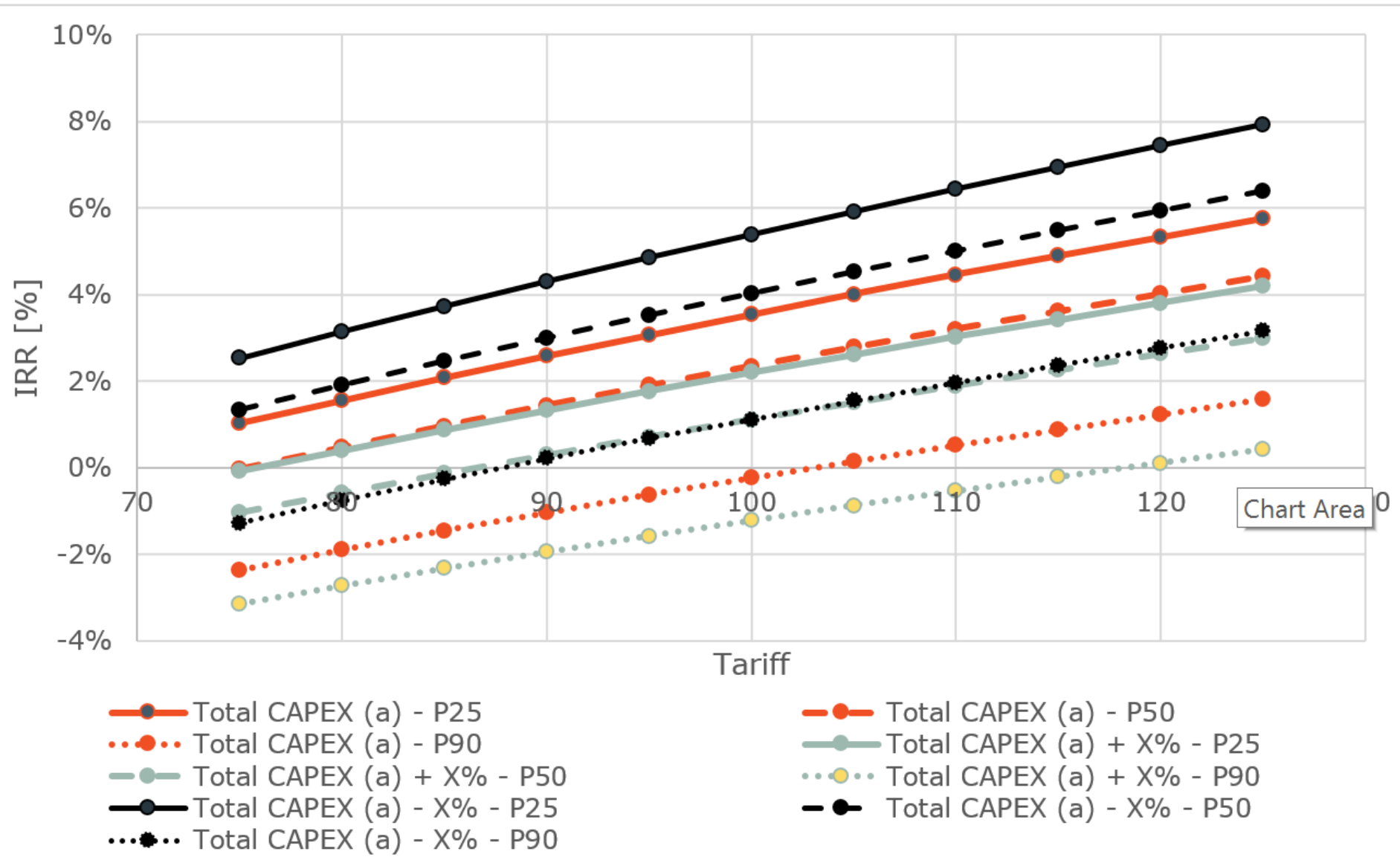


— Class I — Class II — Class III

<b>Power Curve:</b>	
Rated Power	2 MW
Wind Class	III
Cut-out Wind Speed	25 m/s
<b>Park:</b>	
Number of Turbines	1 units
Park Rated Power	2 MW
<b>GROSS Park AEP based on selected wind data and power curve:</b>	
	<b>2,252 MWh</b>
<b>Correctons:</b>	
User identified correction:	0%
<b>Losses - typical values in brackets:</b>	
Wake loss (0 - 15%)	0.0%
Turbine Availabilty loss (3 - 6%)	4.0%
Turbine Performance/degradation loss (1 - 2%)	1.0%
Grid Availabilty loss (0 - 3%)	0.5%
Electrical loss (0.5 - 2%)	1.5%
Environmental loss (0 - 3%)	1.0%
Curtailement loss (0 - 3%)	1.5%
Combined loss and correction	9.2%
<b>NET AEP based on selected Wind Data, Power Curve , Corrections and losses:</b>	
	<b>2,046 MWh</b>
<b>Capacity Factor based on Wind Data and Power Curve, after corrections and</b>	
	<b>11.7 %</b>

5	CAPEX (a)	Per MW installed capacity	1,400,000		PRODUCTION [MWh/y]	AEP (P25)	2,482
6		MW installed	2			AEP (P50)	2,046
7		Total CAPEX (a)	2,800,000			AEP (P90)	1,217
8		Total CAPEX (a) + X%	3,360,000				
9		Total CAPEX (a) - X%	2,240,000		REVENUE	Tariff per MWh	100.00
10						MWh produced per year	2,046
11	CAPEX (b)	WTG cost (total)				Revenue per year	204,579
12		Balance of plant					
13		Grid connection + transmission line					
14		Development cost					
15		Import duties and other costs					
16		Contingency					
17		Hedging cost			CERs	Combined margin	0.97
18		Total CAPEX (b)	0			MWh produced per year	2,046
19		Total CAPEX (b) +X%	0			Amount of CERs (tonnes CO <sub>2</sub> )	1,991
20		Total CAPEX (b) -X%	0			CER price per tonnes CO <sub>2</sub>	0.5
21						Revenue from CERs	0
22		CAPEX Sensitivity Parameter: X [%]	20%				
23							
24	OPEX (a)	Per MWh produced per year	20	iea report	DISCOUNT RATE	In percent	8%
25		MWh produced per year	2,046			Used un calculations	4%
26		Total OPEX (a) per year	40,916				
27							
28	OPEX (b)	Supplier O&M cost per year			TAX	Income tax	25%
29		Project company costs per year					
30		Insurance per year			DEPRECIATION	Depreciation (straight line)	25
31		Concession fee per year					
32		Land rental cost per year					
33		Balancing cost per year					
34		Total OPEX (b) per year					

# Effect of Tarrif on IRR - Comparison of all scenarios



# LCoE - Base scenario results represented by dashed line

